Per ASTM D7205-06 Tensile Testing of Swaged GFRP Rebar

Aslan FRP
Hughes Brothers

TEST MACHINE
Baldwin Model 120 CS S/N: 1005
Electromechanical 120,000 lbs Capacity
Tension/Compression
Certification Number 148101216100627
By Instron 12-October-2016
System - MTest Quattro Admet
Grip V Style Per ASTM E4-13

◉ Production
○ Experimental
○ Durability

Lot Type	
Tested By	R Kruse
Test Date	12/28/2015
Rebar Size	RB6
Sales Order	
Work Order	774293
Date Produced	12/17/2015
Matrix	VE
Formulation	RBVEIP2567-22
Test Temp	71.8°F
Test R/H	19%
Swaged Load Rate	0.40"/min
Reinforcement	ECR-Glass
Filament Diameter	23 Micron
Sizing	Silane
Yield	113
# of Ends	98.5
Sample Length	48.00"
Free Length	34.000"
Anchor Length	
Anchor System	Swaged

Sample #	Load @ Failure (lbs)	Tensile Strength (psi)	Tensile Strength (MPa)	Ultimate Strain (in/in)	Modulus of Elasticity (psi)	Modulus of Elasticity (GPa)
1	52,269.0	118,309.2	815.7	0.0168	7,049,560	48.6
2	53,512.2	121,123.1	835.1	0.0170	7,121,403	49.1
3	55,203.3	124,950.9	861.5	0.0172	7,267,198	50.1
4	52,282.7	118,340.2	816.0	0.0168	7,063,520	48.7
5	53,924.7	122,056.8	841.6	0.0173	7,068,426	48.7
6	53,361.0	120,780.9	832.8	0.0170	7,121,166	49.1
7	52,351.5	118,495.9	817.0	0.0168	7,062,401	48.7
8	52,540.0	118,922.6	820.0	0.0168	7,081,892	48.8
			Averages	0.0169	7,104,446	49.0

	PSI	MPa	Strain
Tensile Strength Average	120,372.5	830.0	
Sigma	2,194.9	15.1	0.0002
3 Sigma	6,584.6	45.4	0.0006
Lot Only σ -3 Sigma	113,787.8	784.6	0.0164

Extensometer Epsilon Model 3543
Certification Number 148101216140227
Calibrated by Instron 12-October-2016
Per ASTM E83-10a

Distance from Anchors	14.00"
LBS of Load at Removal	19,881
Percent of Load at Removal	50%
Span	6.0"

As of 1 Jan 2012: Tensile Strength and Modulus of Elasticity on this sheet are NOT calculated using Actual Cross Sectional Area, but are calculated using a standard Cross Sectional Area.

Sample	Mode of Failure	Line Traceability
1	Delam Center	
2	Delam Center	
3	Delam Bottom	
4	Delam Top	
5	Delam Center	
6	Delam Center	
7	Delam Center	
8	Delam Top	

Surface: Undulated Externally Wrapped
Spacing of Wrap .75 - 1.0"
Silica Sand applied to Surface During Process

* Samples cut using Diamond Blade Cutoff Saw

Actual Ø (in)	Actual CSA A_0 (in)
0.8055"	0.5096"

Rebar Size	Required Tensile Strength(psi / MPa)	Load Cell Min (lbs / N)	Standard Ø (in / mm)	Standard CSA A_0 (in / mm)
6	100,000	44,180	0.7500"	0.4418"
19	689.5	196,523	19.05	285.0

Additional Lab Test Data

Glass to Matrix	74.92 / 25.08	ASTM D2584 By Weight
Barcol Hardness	62.2	ASTM D2583
Transverse Shear	26,526.6 psi	ASTM D7617-11
Apparent Shear	8,463.8 psi	ASTM D4475
Water Absorption Average 24 Hour	0.0367 %	ASTM D570 P7.7

Lot Comments

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(●) Production
( ) Experimental
( ) Durability
Lot Type

Tested By	R Kruse
Test Date	6/5/2017
Rebar Size	RB4
Sales Order	35837
Work Order	827558
Date Produced	5/22/2017
Matrix	VE
Formulation	RBVEIP234-20
Lot Color Code	
Test Temp	75.4°F
Test R/H	29%
Load Rate	0.40"/min
Reinforcement	ECR-Glass
Filament Diameter	23 Micron
Sizing	Silane
Yield	113
# of Ends	44
Sample Length	48.00"
Anchor Length	10.00"
Free Length	28.00"
Potting Material	HydroStone

Sample #	Load @ Failure (lbs)	Tensile Strength (psi)	Tensile Strength (MPa)	Ultimate Strain (in/in)	Modulus of Elasticity (psi)	Modulus of Elasticity (GPa)
1	27,531.0	140,249.6	967.0	0.0201	6,985,028	48.2
2	27,664.6	140,930.2	971.7	0.0201	7,004,607	48.3
3	27,753.1	141,381.0	974.8	0.0203	6,978,530	48.1
4	28,334.8	144,344.4	995.3	0.0206	6,991,297	48.2
5	27,833.7	141,791.6	977.7	0.0203	6,969,777	48.1
			Averages	0.0203	6,985,848	48.2

	PSI	MPa	Strain
Average Tensile	141,739.4	977.3	**Strain**
Sigma	1,399.4	9.6	0.0002
3 Sigma	4,198.1	28.9	0.0006
Lot Only -3 Sigma	137,541.3	948.3	0.0197

Extensometer Epsilon Model 3543
Certification Number 148101216140227
Calibrated by Instron 12-October-2016
Per ASTM E83-10a

Distance from Anchors	
LBS of Load at Removal	9,815
Percent of Load at Removal	50%
Span	6.0"

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Surface: Undulated Externally Wrapped
Spacing of Wrap .75 - 1.0"
Silica Sand applied to Surface During Process

* Samples cut using Diamond Blade Cutoff Saw
** Anchorages are cut to length and wheel abrated
Schedule 40 Pipe

Sample	Mode of Failure	Line Traceability
1	Delam Center	
2	Delam Center	
3	Delam Center	
4	Delam Center	
5	Delam Center	

Measured ∅ (in)	Measured CSA A_0 (in)
0.5501	0.2377

Rebar Size	Required Tensile Strength(psi / MPa)	Load Cell Min (lbs / N)	Standard ∅ (in / mm)	Standard CSA A_0 (in / mm)
4	110,000	21,593	0.5000	0.1963
13	758.4	96,078	12.70	126.7

Metric Reference

Additional Lab Test Data

Glass to Matrix	75.14 / 24.86	By Weight
Barcol Hardness	60.4	ASTM D2583
Apparent Shear	6,546.3 psi	ASTM D4475
Water Absorption Average 24 Hour	0.1364 %	ASTM D570 P7.7

Lot Comments

Hughes Brothers, Inc. Seward, NE

Per ASTM D7205-06 Tensile Testing of GFRP Rebar

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Hughes Brothers

TEST MACHINE
Baldwin Model 120 CS S/N: 1005
Electromechanical 120,000 lbs Capacity
Tension/Compression
Certification Number 148101216100627
By Instron 12-October-2016
System - MTest Quattro Admet
Grip V Style Per ASTM E4-13

◉ Production
○ Experimental
○ Durability
Lot Type

Rebar Size	RB5
Sales Order	
Work Order	744445
Date Produced	4/6/2015
Matrix	VE
Formulation	RBVEIP2567-22
Test Temp	70.4°F
Test R/H	22%
Load Rate	0.50"/min

Tested By	
Test Date	4/13/2015
Reinforcement	ECR-Glass
Filament Diameter	23 Micron
Sizing	Silane
Yield	113
# of Ends	68
Sample Length	48.00"
Free Length	28.00"
Anchor Length	10.00"
Potting Material	M-183

Sample #	Load @ Failure (lbs)	Tensile Strength (psi)	Tensile Strength (MPa)	Ultimate Strain (in/in)	Modulus of Elasticity (psi)	Modulus of Elasticity (GPa)
1	35,994.0	117,320.7	808.9	0.0159	7,375,023	50.8
2	35,064.3	114,290.4	788.0	0.0159	7,172,425	49.5
3	37,947.6	123,688.4	852.8	0.0176	7,014,636	48.4
4	36,929.5	120,369.9	829.9	0.0178	6,755,913	46.6
5	37,299.0	121,574.3	838.3	0.0173	7,026,167	48.4
6	36,974.7	120,517.3	831.0	0.0170	7,081,964	48.8
7	37,843.4	123,348.8	850.5	0.0173	7,129,344	49.2
8	36,275.0	118,236.6	815.2	0.0170	6,969,579	48.1
			Averages	0.0170	7,065,631	48.7

	PSI	MPa	Strain
Tensile Strength Average	119,918.3	826.8	
σ Sigma	2,969.3	20.5	0.0007
3σ Sigma	8,908.0	61.4	0.0020
Lot Only -3σ Sigma	111,010.3	765.4	0.0150

Extensometer Epsilon Model 3543
Certification Number 148101216140227
Calibrated by Instron 12-October-2016
Per ASTM E83-10a

Distance from Anchors	11.000"
LBS of Load at Removal	14,573
Percent of Load at Removal	50%
Span	6.0"

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Sample	Mode of Failure	Line Traceability
1	Delam Center	
2	Delam Center	
3	Delam Center	
4	Delam Center	
5	Delam Center	
6	Delam Center	
7	Delam Center	
8	Delam Center	

Surface: Undulated Externally Wrapped
Spacing of Wrap .75 - 1.0"
Silica Sand applied to Surface During Process
* Samples cut using Diamond Blade Cutoff Saw
** Anchorages are cut to length and wheel abrated Schedule 40 Pipe

Rebar Size	Required Tensile Strength psi / MPa	Load Cell Min (lbs / N)	Standard ∅ (in / mm)	Standard CSA A_0 (in / mm)
5	105,000	32,214	0.6250	0.3068
16	724.0	143,298	15.88	197.9

Measured ∅ (in)	Measured CSA A_0 (in)
0.6750	0.3578

Metric References

Additional Lab Test Data

% Glass to Matrix	74.40 / 25.60	ASTM D2584 By Weight
Barcol Hardness	64.8	ASTM D2583
Transverse Shear	31,279.3 psi	ASTM D7617-11
Apparent Shear	8,561.3 psi	ASTM D4475
Water Absorption Average 24 Hour	0.1162 %	ASTM D570 P7.7

Lot Comments _____ Hughes Brothers, Inc. Seward, NE

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Tension/Compression
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Grip V Style Per ASTM E4-13

◉ Production
○ Experimental
○ Durability

Lot Type

Tested By

Test Date 10/13/2014

Rebar Size	RB8
Sales Order	
Work Order	723285
Date Produced	8/11/2014
Matrix	VE
Formulation	RBVEIP28910-22
Test Temp	72.7°F
Test R/H	34%
Swaged Load Rate	0.50"/min

Reinforcement	ECR-Glass
Filament Diameter	23 Micron
Sizing	Silane
Yield	113
# of Ends	174.5
Sample Length	48.00"
Free Length	32.00"
Anchor Length	
Potting Material	Swaged

Sample #	Load @ Failure (lbs)	Tensile Strength (psi)	Tensile Strength (MPa)	Ultimate Strain (in/in)	Modulus of Elasticity (psi)	Modulus of Elasticity (GPa)
1	86,018.6	109,522.0	755.2	0.0153	7,173,659	49.5
2	86,413.3	110,024.6	758.6	0.0159	6,915,123	47.7
3	86,293.5	109,872.0	757.6	0.0156	7,061,462	48.7
4	82,052.0	104,471.6	720.3	0.0150	6,977,630	48.1
5	87,852.3	111,856.8	771.3	0.0159	7,048,916	48.6
6	81,170.2	103,348.9	712.6	0.0146	7,057,686	48.7
			Averages	0.0154	7,039,079	48.5

	PSI	MPa	Strain
Average Tensile	108,182.6	745.9	
Sigma	3,127.2	21.6	0.0005
3 Sigma	9,381.7	64.7	0.0014
Lot Only -3 Sigma	98,801.0	681.2	0.0140

Extensometer Epsilon Model 3543
Certification Number 148101216140227
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Distance from Anchors	
LBS of Load at Removal	31,416
Percent of Load at Removal	50%
Span	6.0"

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* Samples cut using Diamond Blade Cutoff Saw

Sample	Mode of Failure	Line Traceability
1	Delam Center	
2	Delam Center	
3	Delam Center	
4	Delam Center	
5	Delam Center	
6	Delam Center	

Actual Ø (in)	Actual CSA A_0 (in)
1.0460	0.8592

Rebar Size	Required Tensile Strength (psi / MPa)	Load Cell Min (lbs / N)	Standard Ø (in / mm)	Standard CSA A_0 (in / mm)
8	90,000	70,686	1.0000"	0.7854"
25	620.5	314,436	25.40	506.7

Metric Reference

Additional Lab Test Data

Glass to Matrix	75.62 / 24.38	By Weight
Barcol Hardness	62.4	ASTM D2583
Apparent Shear	7,355.1 psi	ASTM D4475
Water Absorption Average 24 Hour	0.0137 %	ASTM D570 P7.7

Lot Comments

Hughes Brothers, Inc. Seward, NE